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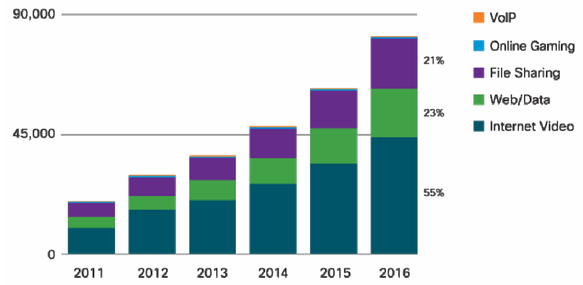
Cache as a Service: Leveraging SDN to Efficiently and Transparently Support Video-on-Demand on the Last Mile

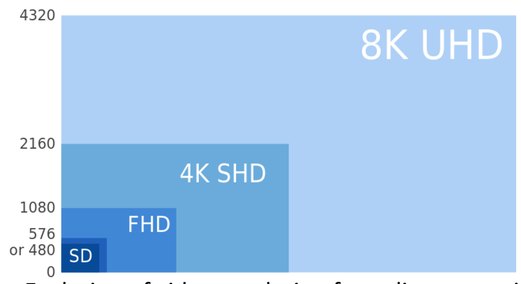
Motivation

- Globally, **Internet video traffic was 57% of all consumer Internet traffic** in 2012 and will be 69% in 2017 [1]
- **Mobile video traffic** exceeded 50% for the first time in 2012 [2]



Global consumer Internet traffic in Petabytes/month[2]

- **High-Definition VoD surpassed Standard-Definition VoD** in 2011. By 2016, 79% of Internet VoD will be HD [1]
- **Trend to improve video quality even more** as we move to Ultra-HD (4K-8K) and 3DTV that support 4 times higher resolution than HD



Evolution of video resolution for online streaming

[1] Cisco VNI Global Forecast (2012) / [2] Cisco VNI Mobile Forecast (2013)

Observations

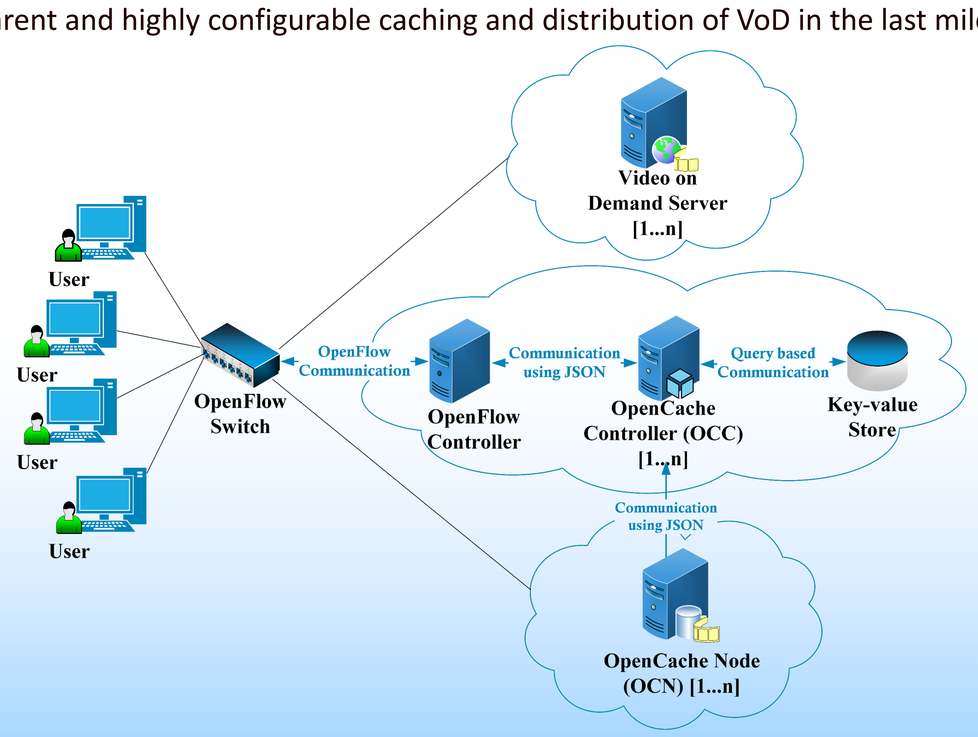
- Video streaming is fast becoming an **essential part of consumers' lives**
- The network has now to transfer an **enormous amount of video traffic** (~45.000 Petabytes per month in 2016); big strain on the network
- **We need a solution** that :
  - **Ensures high-throughput end-to-end** (especially with HD)
  - **Minimizes distance between source video content server and user** so that data transfer occurs quickly & reliably to the user -> increased Quality of Experience (QoE)

Challenges with Video-on-Demand

- Currently VoD requests are **handled naively**; there is an independent flow per request
- These flows are **duplicated** minutes, hours or days later (by same or different user)
- We observe identical delivery of media objects through the same network segments
- Consequently, the end-to-end capacity of network infrastructure must grow continuously to match the increasing number of Internet video users
- The increasing popularity of VoD and especially of HD content worsens this

OpenCache Architecture

OpenCache is an **OpenFlow-assisted in-network caching service** that provides efficient, transparent and highly configurable caching and distribution of VoD in the last mile



OpenCache is

Transparent

- Cache delivery undetectable to client
- No need for new client h/w or s/w
- Retains underlying delivery mechanism
- Works with existing caches and CDNs

Extensible (API)

- Exposes an interface for third parties
- Enables part or all of the caches to be provisioned at will by cache owner
- Simple integration of new instances

Adaptive

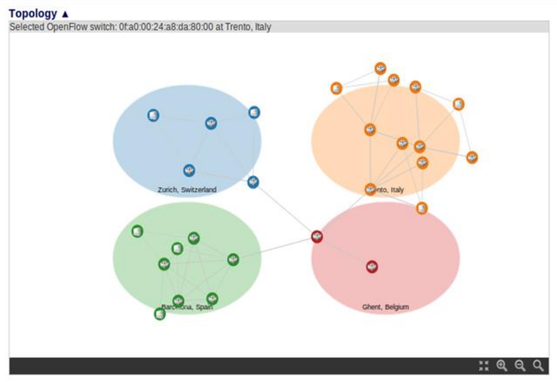
- Uses real-time metrics from OpenFlow switching hardware
- Supplemented with live cache hit and miss metrics
- Enables informed decisions by operators

Efficient

- Reduces the repeated delivery of identical content; satisfy requests locally
- Reduces inter-domain traffic and cost
- Retains unified point of control
- New revenue stream for network operator

Evaluation on OFELIA

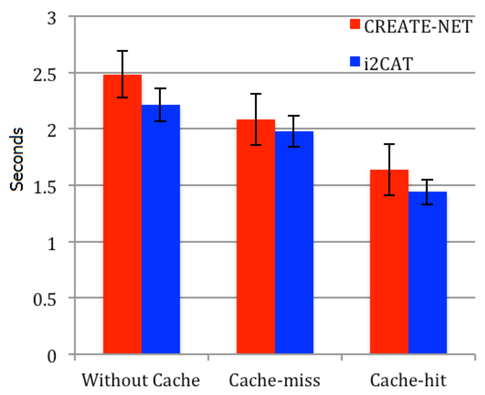
- **OFELIA** is an OpenFlow pan-European experimentation testbed
- **Topology :** Deployed OpenCache on three OFELIA islands distributed geographically
  - Switzerland : ETH Zurich
  - Italy : Create-NET
  - Spain : i2CAT
- **Tests :** Over 120 inter-island (federated) VoD experiments using an adaptive video streaming technology (MPEG-DASH)



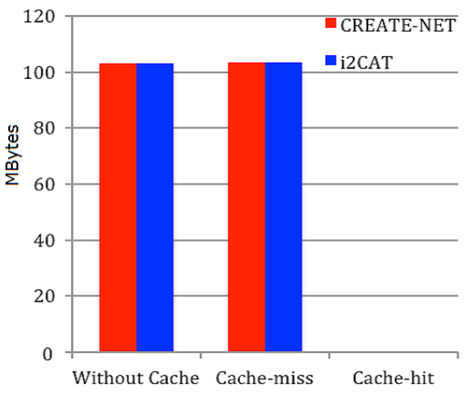
- **Evaluation Criteria** :
  - **Startup delay** (QoE metric)
  - External link **network utilization**
  - **Video quality (bitrate)** requested (QoE metric)

Key Results

- **Reduced startup delay** up to **35%** -> **increased QoE for end-user**
- External **link utilisation reduced to virtually zero** (only background traffic remained)

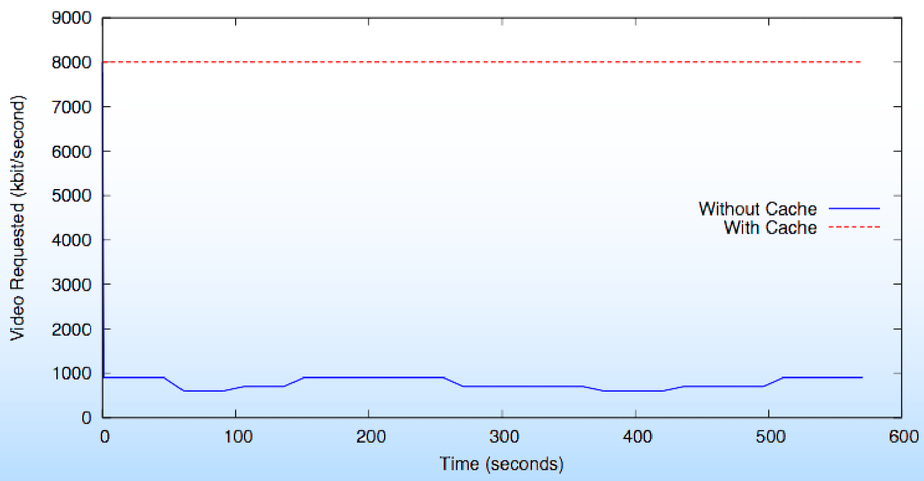


Average Start- Up Delay



External Link Utilisation

- **Increased video quality;** requested bitrate 8 times higher **-> increased QoE for end-user**



Quality (bitrate) requested by MPEG-DASH Client

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